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Destined for Slaughter: Identifying Seasonal Breeding Patterns in Sheep and Goats in Early Babylonia

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Introduction

An improved understanding of the seasonality of birth and breeding activities of sheep and goats in early Mesopotamia contributes to our reconstruction of the strategies of ancient breeding practices and the responses to the rhythm of both pastoral and administrative tasks. Further, it gives us an overall appreciation of the socioeconomic organization of Mesopotamian society in the late third millennium BC. The reproductive cycle in sheep and goats is a central parameter in animal management systems, and determines not only the availability of animal resources (e.g., milk and wool), but may also have an impact on the timing of various pastoral activities and slaughtering strategies. For the nomadic and semi-nomadic pastoralists and transhumant herders operating in the "periphery" of the Ur III state (as defined by Piotr Steinkeller in his seminal paper from 1991),[1] who supplied a significant portion of the animals that went through the animal livestock center Puzriš-Dagan, the seasonal breeding cycle of the animals was an important factor for the herding of the animals, and no doubt played a role in defining the movement of the community as a whole. Moreover, a better understanding of the dynamics of state-pastoralist interaction may also improve our appreciation of the underlying military and political strategies of the Ur III state. Anne Porter has recently argued that Šulgi's militaristic expansion of the Ur III state into the Zagros, which coincided with the foundation of Puzriš-Dagan, was part of the state's progressive appropriation of all aspects of the economy, and that much of the autonomy and grazing land of the transhumant pastoralists in the northeast of Babylonia and the Zagros mountains were lost in this process of centralization.[2]

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[1] Steinkeller, "Administrative and Economic Organization" (1991).
[2] Porter, *Mobile Pastoralism*, 296–97.

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This article aims to revisit the debate concerning the meaning of the Sumerian classification $sila_4$/$maš_2$ nu_2/nu-a, used for sexually mature ewes and does in the Ur III administrative texts from Puzriš-Dagan. I adopt a more interdisciplinary approach to the discussion by incorporating ethnographic data as well as studies on reproductive patterns of domestic sheep and goats in early Mesopotamia and elsewhere. An analysis of all attestations of the expression of this classification in the Ur III record offers important information on the seasonal mating cycle of sheep and goats in Puzriš-Dagan, and supports an understanding of it as a reference to infertile animals or poor producers in general, as argued by Wolfgang Heimpel in 1993 and Wu Yuhong in 1996.[3] The correct understanding of the expression in the Sumerian administrative documents allows us to reconstruct the reproductive cycle of the sheep and goats. If Heimpel and Wu are correct in their interpretation of the expression, it would suggest a relatively short mating season in the autumn (September–October), with the majority of the small livestock in Puzriš-Dagan born in the first few months of the year (February–March).

The administration of the Ur III state has been described as an oppressive and unyielding centralized bureaucracy, with an omnipresent control over all aspects of Mesopotamian society and economy. This rather bleak picture of the Ur III organization has recently been challenged by Steven Garfinkle, who has argued for a more nuanced understanding of the Ur III state, as a patrimonial household economy characterized by the persistence of local hierarchies.[4] Ultimately, our understanding of the nature of the Ur III bureaucracy must be based on our interpretation of its administrative texts. An enhanced understanding of the interrelation between the royal administrators operating in Puzriš-Dagan (and Ur[5]) and the pastoral communities in the outlying territories of the state may shed light on how—and to what extent—the central authority and its administrative apparatus influenced and controlled the lives and livelihood of the people living in these marginal areas. The article argues that the administration and bureaucracy of the Ur III state remained largely unaffected by the seasonal reproductive cycles of the sheep and goats collected in Puzriš-Dagan.

A few preliminary words about Puzriš-Dagan are necessary at the outset. The livestock management center Puzriš-Dagan was officially established by the Ur III king Šulgi, announced in his thirty-ninth year-name, with the main purpose of collecting, registering, and managing different types of livestock, which often (but not always) were brought in from the outer regions of the state. Most of the livestock, which was primarily destined for consumption and cult observances, was distributed from Puzriš-Dagan to the major temples and important institutions in the cities in central and southern Babylonia. Some animals, however, would also be added to local herds administrated by the palace, and distributed to the "fields" (a-$ša_3$) around Puzriš-Dagan.[6] The majority of the livestock appear to have been brought in as different types of taxes or as loot from military campaigns to peripheral areas of the state north and northeast of Babylonia along the Zagros range.[7] Puzriš-Dagan itself was in all likelihood located on a branch of the Euphrates,[8] some 10 kilometers southeast of Nippur in central Babylonia.[9] However, in contrast to the Ur III provincial capitals and their subsidiary cities and towns, which largely operated within their own administrative and economic structures, Puzriš-Dagan was directly subordinated to the royal bureaucracy. The city was an artificial creation of the king as an administrative and economic tool of the state, and all officials operating within this extensive livestock redistributive system were selected by the king himself.[10]

[3] Heimpel, "Zu den Bezeichnungen von Schafen und Ziegen" (1993); Wu, "Ewes Without Lambs" (1996).

[4] Garfinkle, "Was the Ur III State Bureaucratic?" (2008), with literature. Other recent studies that have argued for a more balanced approach to the Ur III state, with a greater emphasis on continuity than on transition and disruption, include Garfinkle, "Limits of State Power" (2013); Michalowski, "Charisma and Control" (1991); and Michalowski, "Networks of Authority" (2013), 169–205.

[5] See Tsouparopoulou, "Central Livestock Agency" (2013): 10–11; Cripps, "Structure of Prices" (2019): 57 n. 12.

[6] Sallaberger, "Schlachtvieh aus Puzriš-Dagān" (2004): 47.

[7] Steinkeller "Administrative and Economic Organization" (1991), 27–32; see also Sallaberger "Schlachtvieh aus Puzriš-Dagān" (2004): 48. For a more recent survey of the eastern and northern military expansion of the Ur III state, see Michalowski, *Correspondence of the Kings of Ur* (2011), 96–105; and Garfinkle, "Limits of State Power" (2013), 160–62.

[8] Steinkeller, "Hydrology and Topography" (2001). Recent studies on the archaeology of Puzriš-Dagan include Tsouparopoulou, "'Counter-Archaeology'" (2017), Shalkham, "Iraqi Excavation at Drehem" (2017), and Marchetti, et al., "Iraqi-Italian 2016 Survey Season" (2017).

[9] Sharlach, *Provincial Taxation* (2004), 11.

[10] Tsouparopoulou, *Ur III Seals* (2015), 9.

The Sumerian Expressions u_8 $sila_4$ nu_2/nu-a and ud_5 $maš_2$ nu_2/nu-a

The Sumerian expressions u_8 $sila_4$ nu_2/nu-a and ud_5 $maš_2$ nu_2/nu-a were used as a classification for a specific type of ewes (u_8) and does (ud_5) in the Ur III administrative texts from the livestock center Puzriš-Dagan. I know of only one attestation where the expression was used in an identical format as a designation for cows, from the city of Nippur: ab_2 amar nu_2-a (BE 3/1 79; see further below). The traditional and currently prevailing understanding of the expression is that it was a designation for pregnant ewes and does. However, it has been known for some time that this understanding produces several contextual and philological problems, and more recently, an alternative interpretation of the expression as a reference to infertile animals has been put forward. No clear consensus has been reached, and the various interpretations of the expression warrant some further consideration.

Pregnant

It was Leo Oppenheim who first suggested in 1948 that the expression alluded to pregnant animals, translating u_8 $sila_4$ nu_2-a "sheep big with lamb," referring to the meaning "to cover" (alluding to German "belegen") for the verb in the expression, which he read as na_2.[11] Oppenheim did not connect the nu_2-a in his text with the nu-a, which he instead understood as a phonetic variant of the du_3-a used in the otherwise identical expression u_8/ud_5 $sila_4$/$maš_2$ du_3-a, an expression he believed was used for animals after parturition: "she-goat which has kidded" or "ewe which has (already) ewed."[12] However, we may now with some confidence conclude that the expression u_8/ud_5 $sila_4$/$maš_2$ du_3-a was used as a designation for pregnant animals in the Ur III texts.[13]

Oppenheim did not further elaborate on his understanding of the verb na_2 as "to cover" in favor of the more established translation "to lie down" (Akk. *niālum*) offered in, e.g., Anton Deimel's *Šumerisches Lexikon*,[14] the standard Sumerian dictionary at the time. It is surprising that Oppenheim did not consider this meaning of the verb, since both ewes and does often (but not always) give birth lying down, and a translation of the expression as "ewe/doe that will lay down (with) lamb/kid" would work well contextually with Oppenheim's understanding of the expression as a designation for pregnant animals. Oppenheim also did not explain how or why he understood the verb na_2 as "to cover," thus offering that the literal translation of the expression "ewe/doe (to be) covered with lamb/kid" should be translated "ewe/doe big with lamb/kid,"[15] and—by extension—be understood as a reference to pregnant animals.

Benno Landsberger continued to read the verb in the expression as na_2 (rather than nu_2), but noted that the frequently occurring nu-a was not (as argued by Oppenheim) a variant of du_3-a in the expression u_8/ud_5 $sila_4$/$maš_2$ du_3-a, but should instead be understood as a phonetic variant of na_2-a.[16] In Tablet 13 of the bilingual lexical series ḪAR-ra = *ḫubullû*, which dates to the Old Babylonian period, the nu_2-a appeared to correspond to the Akkadian adjective *nīlum*, "recumbent," producing the translation "recumbent ewe (with) her lamb" (line 190) or "recumbent cow (with) her calf" (line 339), which Landsberger naturally, and in agreement with Oppenheim, interpreted as a designation of pregnant animals.[17]

Infertile

The u_8/ud_5 $sila_4$/$maš_2$ nu_2/nu-a phrase was revisited in 1993, when Wolfgang Heimpel offered an alternative analysis and interpretation of the expression in a comprehensive study on Ur III sheep and goat terminology published in the biannual *Bulletin on Sumerian Agriculture*. According to Heimpel, nu_2 should be understood as a phonetic variant of nu (rather than the other way around).[18] The nu-a would simply mean "without," formed with the modal prefix nu- used for negations, and the subordination suffix -a.[19] The

[11] Oppenheim, *Catalogue Eames* (1948), 82.

[12] *Ibid.*, 11.

[13] See, e.g., Heimpel "Bezeichnungen von Schafen und Ziegen" (1993): 134; Steinkeller "Sheep and Goat Terminology" (1995): 55. For the ab_2 amar du_3-a next to the ab_2 amar nu_2-a in *BE* 3/1 79, see also Oppenheim, *Catalogue Eames*, 82.

[14] Deimel, *Šumerisches Lexikon* (1932), no. 431.

[15] Note that Oppenheim and Hartman ("Domestic Animals" [1945]: 166–67) also offered the translation "ewe big with lamb" for the expression, using what they (incorrectly) reconstructed as [d]u-a, in their edition of ḪAR-ra = *ḫubullû*, Tablet 13.

[16] Landsberger, *Fauna* (1960), 27 and 49.

[17] *Ibid.*, 27 and 56.

[18] Heimpel "Bezeichnungen von Schafen und Ziegen" (1993): 133–34.

[19] See Thomsen, *Sumerian Language* (1984), 92. Note that the understanding of nu-a as "without," and the possible connection with nu_2-a in our expression, was in fact proposed by Dietz Otto

expression would thus be translated "ewe/doe without lamb/kid," which Heimpel interpreted as a designation used for infertile or barren animals. It should be noted that an expression nu-a with the meaning "without" does not appear in other contexts in the Ur III texts beyond ewes and does.

If Heimpel's interpretation is correct, the expression would stand in a natural opposition to the structurally identical animal designation u_8/ud_5 $sila_4$/$maš_2$ du_3-a, which in all likelihood should be understood as "ewe/doe planted (with) lamb/kid," i.e., a pregnant animal.[20] The aforementioned text BE 3/1 79 from Nippur is of relevance here. This text records three cows as amar nu_2-a immediately after it enumerates one or more cow(s) described as amar du_3-a. In other words, if we agree with Heimpel and Steinkeller that ab_2 amar du_3-a is a reference to pregnant cows, then it follows that ab_2 amar nu_2-a cannot be an identical reference to pregnant cows. Steinkeller was, of course, aware of these references in BE 3/1 79,[21] but he did not elaborate on the implications of this text for our understanding of either of these two expressions.

The recently-published text PPAC 5 315 from Girsu provides further support for Heimpel's rejection of ab_2 amar nu_2-a as a designation for pregnant cows; it also offers some validation for his understanding of the nu_2-a/nu-a as "without" in this particular context. In this text, several small groups of calves are referred to with the expression amar ab_2 nu_2-a. The understanding of amar ab_2 nu_2-a as "calf without cow," with nu_2-a as a phonetic variant of nu-a, "without," would be perfectly feasible, and seems to fit the context in the text very well, since the calves listed in this way are the only ones in the text that are not referred to as suckling animals. Naturally, these "calves without cows" (i.e., orphaned or abandoned calves) would not be suckling animals. For obvious reasons, the alternative understanding of the expression as "calf pregnant with cow" must be rejected here. In the final column, PPAC 5 315 provides the following totals (ŠU+NIGIN$_2$): 222 suckling heifer calves (ab_2 amar ga), 228 suckling bull calves (gu_4 amar ga), and eleven "calves without cows" (amar ab_2 nu_2-a). These numbers would indicate that 2–3% of the Ur III calves would be orphaned or rejected by their mothers. Occurrences of cows initially (and sometimes permanently) rejecting their calves are relatively rare in livestock breeding, and would primarily happen with first-time heifers. G. Illmann and M. Špinka observed only one rejection of a newborn calf in a sample of thirty-one dairy heifers in group housing (3.2%).[22] It should be noted, however, that both housing conditions and various bonding strategies greatly affect cow-calf rejection rates,[23] and the rates in modern breeding scenarios will no doubt differ from those in ancient Mesopotamia.

A clear advantage of Heimpel's re-interpretation of the expression is that it would explain the fact that some of the animals "without lamb/kid" were destined for consumption. These were disbursed to the (royal) kitchen (or "commissariat") referred to as e_2-muhaldim, or to the mysterious institution e_2-uz-ga (perhaps "House of Restriction") which, among other things, prepared exclusive food for the royal court and the uppermost elite of Ur III society.[24] Obviously, such frequent disbursements would tally poorly with Oppenheim's original interpretation as a reference to pregnant animals, since it would be difficult to explain why the Ur III administration should identify and deliberately select pregnant animals for slaughtering and consumption. The opposite situation, on the other hand—i.e., the identification and selection of infertile animals for culling and consumption—would be reasonable and expected in any breeding scenario, ancient or modern.

Aside from the apparent lack of support in the Old Babylonian lexical text ḪAR-ra = *ḫubullû*, Tablet 13, the main problem with Heimpel's analysis and interpretation of the expression is no doubt the use of the

Edzard almost twenty years before Heimpel's article (Edzard, "*Hamṭu*, *marû*," [1976]: 61).

[20] See Heimpel, "Bezeichnungen von Schafen und Ziegen" (1993): 134; Steinkeller "Sheep and Goat Terminology" (1995): 55. Note that a similar structural opposition is attested in Puzriš-Dagan, with dead animals designated as "among the newborn (ones)" ($ša_3$ u_4-tu-da) beside animals designated as "among the old (ones)" ($ša_3$ libir) (see Hilgert, *Drehem Administrative Documents* [2003], 71 and 74, nn. 243 and 244).

[21] See Steinkeller "Sheep and Goat Terminology" (1995): 68 and 94.

[22] Illman and Špinka, "Maternal Behaviour of Dairy Heifers" (1993): 93.

[23] Von Keyserlingk and Weary, "Maternal Behavior in Cattle" (2007).

[24] Wu "Ewes Without Lambs": 73–76. For the e_2-muhaldim as an industrial kitchen or commissariat, responsible for the preparation and provision of food to local officials and administrators, work gangs, royal messengers, foreign envoys, and military personnel, see Sallaberger "Schlachtvieh aus Puzriš-Dagān" (2004): 58–60; and Allred, *Cooks and Kitchens* (2006). For the e_2-uz-ga, see Sigrist, *Drehem* (1992), 158–62; Wu "Ewes Without Lambs" (1996); Wu, "Pairs of Cooks" (2013); and Sallaberger "Schlachtvieh aus Puzriš-Dagān" (2004): 58–60.

graphically complicated sign nu_2 as a phonetic representation of the extremely simple sign nu. According to Heimpel, nu_2 was replaced by nu sometime towards the end of year Amar-Suen 3,[25] although he also acknowledged that there are several exceptions to this general observation. He also (correctly) pointed out that the replacement of the sign nu_2 with a phonetic rendering using the simple sign nu would be perfectly reasonable. Heimpel struggled to provide a satisfactory explanation for the real problem here, which is the seemingly inexplicable and opposite circumstance that the Ur III administrators originally should have decided to render the intended nu sign with the more complicated sign nu_2: "Ich nehme daher an, dass etymologisches **nu** in Drehem aus unefindlichen Gründen bis AS 3 mit dem komplizierten Zeichen **nú** geschrieben wurde."[26]

Pregnant—Again

Heimpel's radical reinterpretation of the animal designation would not go unchallenged. In the following volume of the *Bulletin on Sumerian Agriculture* from 1995, in an exhaustive article on sheep and goat terminology in Puzriš-Dagan, Steinkeller argued against Heimpel's interpretation, in favor of the traditional understanding of the expression. Steinkeller's primary objection to Heimpel's new interpretation was that it was very common in the texts from Puzriš-Dagan: "In my view, this interpretation is extremely unlikely, primarily because this description is very common at Drehem."[27]

Although we may conclude that the animal description under discussion here is attested almost 300 times in approximately 200 different tablets from Puzriš-Dagan,[28] Steinkeller's assessment of the expression as "very common" in the city is rather subjective, and requires some consideration. According to the online catalogues of the Cuneiform Digital Library Initiative (CDLI) and the Database of Neo-Sumerian Texts (BDTNS),[29] approximately 16,000 cuneiform tablets from Puzriš-Dagan have been published to date, of which approximately 97% come from a period of thirty years, from Šulgi 39 to Ibbi-Suen 2.[30] Practically all of these texts can be connected to Puzriš-Dagan's main role as a center within the Ur III state for the collection, management, and distribution of livestock. More specifically, approximately half of all published tablets from Puzriš-Dagan (i.e., some 8,000 tablets) are concerned with small livestock, together producing approximately 30,000 individual references to (groups of) different kinds of sheep and goats. Based on the text AO 19548,[31] which lists animals disbursed from the account of Nasa over a period of sixty months during the final years of Šulgi's reign,[32] Marcel Sigrist was able to calculate that, on the average, some 70,000 ovines were booked out of Puzriš-Dagan annually. Sigrist further suggested that in order to sustain the animal stocks managed by Puzriš-Dagan, it was unlikely that more than an estimated 5% of the total number of animals would be removed from the herds in a single year,[33] which in turn would mean that at any given time, more than a million sheep and goats were administered by the various officials stationed in Puzriš-Dagan.[34]

Considering such astonishing numbers (and regardless of the exactness and accuracy of such estimates), it is difficult to accept Steinkeller's argument that some 200 tablets listing approximately 750 sheep and goats with the designation under discussion should make it

[25] Heimpel, "Bezeichnungen von Schafen und Ziegen" (1993): 133.

[26] *Ibid.*: 133. It should be noted that nu-a (rather than nu_2-a) is occasionally also attested in texts dating to the period before the end of Amar-Suen 3 (e.g. *BCT* 1 35 [Šulgi 46], *NYPL* 4 [Šulgi 46], *UDT* 104 [Amar-Suen 1]).

[27] Steinkeller, "Sheep and Goat Terminology" (1995): 55.

[28] According to BDTNS, there are 278 attestations in 199 different tablets, and a total of 745 individual animals with the classification (296 ewes and 449 does).

[29] See https://cdli.ucla.edu and http://bdtns.filol.csic.es.

[30] See Tsouparopoulou, *Ur III Seals* (2015), 12.

[31] See Calvot, "Deux documents" (1969): 101–103 and 110.

[32] Nasa was the chief official in Puzriš-Dagan between Šulgi 42 and Amar-Suen 2 (Tsouparopoulou, "Central Livestock Agency" [2013]).

[33] Sigrist, *Drehem* (1992), 33–34.

[34] That so many animals should have been physically kept in or around Puzriš-Dagan seems questionable based on logistics alone, and we have to agree with, e.g., Christina Tsouparopoulou, that many of the animals appearing in the Puzriš-Dagan texts in all likelihood were managed elsewhere, and only entered the livestock center as records and numbers in its administrative documentation (Tsouparopoulou "'Counter-Archaeology'" [2017], 615–16). Note, however, John Robertson, who has argued that the records from Puzriš-Dagan concern genuine collections of animals, and that the center may have kept as many as 350,000 sheep and goats in any given year (Robertson, "Social and Economic Organization of Temples" [1995], 446). For a general discussion of Ur III institutions actively involved in real transactions as well as serving as purely administrative units separated from any physical activities—as well as the archives documenting those activities—see Steinkeller, "Function of Written Documentation" (2004) and Widell, "Administration of Storage" (2018). For a recent discussion of the administrative function of Ur III texts and archives, see Garfinkle, "Ur III Administrative Texts" (2015).

"too common" for Heimpel's reinterpretation. On the contrary, if these 750 animals over this thirty-year period were indeed classified as barren or infertile as Heimpel has suggested, we would have to conclude that animal infertility was severely underreported in Puzriš-Dagan.

The Identification of Infertility and Poor Producers

Steinkeller also pointed out that the comparable expression using du_3-a (instead of nu_2/nu-a)—almost certainly being a reference to pregnant animals—remains rare in the texts, and concluded:

> If the former expression [u_8/ud_5 $sila_4$/$maš_2$ nu_2/nu-a] were to mean "infertile", we would be forced to conclude that, at Drehem, infertile animals were regularly identified (by what means and for what purpose?), whereas pregnant ones [referred to with u_8/ud_5 $sila_4$/$maš_2$ du_3-a] were not. This I find impossible to accept.[35]

This notion fails to recognize the importance of the proper identification of infertile or non-productive animals in any animal management system, and that it is standard practice among sheep and goat breeders to identify and remove poor breeders from the herds.[36] A recent study of traditional livestock breeding practices among Somali pastoralists has demonstrated that out of fifteen different criteria for culling ewes and does, the inability to become pregnant (infertility) was considered the second most important criterion, superseded only by old age.[37] Other relevant culling criteria among the sheep and goat pastoralists included, for example, animals with a history of abortion (sixth most important), stillbirth (eighth), and the death of offspring after abandonment (ninth). In traditional sheep and goat husbandry, the voluntary culling of mature animals for non-conception was an important factor in maintaining and improving flock productivity over a longer period of time. It seems very unlikely that the Ur III administration should have lacked established routines and practices for selective culling in its meticulously managed sheep and goat herds.[38]

Pregnancy in sheep and goats is not easily detected based simply on visual inspection or palpation (the gentle manipulation of the animal's abdomen), and can often only be securely identified towards the end of the gestation period, which is approximately at five months for both sheep and goats.[39] However, there are two relatively easy ways of identifying poor breeders or infertility in ewes and does based on observation alone. The first opportunity for such observations is from the very beginning of, and throughout, the mating season, while the second opportunity arises from the end of the gestation period, and throughout the period of parturition.

The two opportunities can be described as follows. In the first instance, ewes/does are only receptive to sexual advances from the ram/buck during estrus (i.e., when "in heat"), which for ewes and does will last between twelve to thirty-six hours. The estrus is followed by a "breeding rest," during which the ewe or doe will not stand and therefore allow the ram or buck to breed her. The estrus cycle is repeated every thirteen to nineteen days for sheep, and eighteen to twenty-four days for goats. If a ewe or doe for some reason is repeatedly (i.e., in more than one estrus cycle) not coming into heat, and therefore never mounted by the ram/buck in the herd, she should be considered for culling in order to achieve and maintain the most productive demographic structure of the herd. Identification of ewes/does not pairing is best done through constant observation of the herd. Alternatively, ochre dye can be applied to the chests of the rams/bucks used to service the herd. The dye will rub off onto the ewes/does during pairing, thus singling out any females not being mounted.

In the second instance, it is possible, towards the end of gestation, for an experienced shepherd to identify

[35] Steinkeller, "Sheep and Goat Terminology" (1995): 55.

[36] For example, the Ohio State University "Sheep Team" considers poor productivity the most important factor when culling the flock, and offers the following advice to modern sheep breeders (https://u.osu.edu/sheep/2008/08/29/culling-the-sheep-flock/, accessed May 2020): "When deciding which ewes should be culled from the flock, first eliminate those open ewes and those that have lost lambs due to excessive lambing difficulty, as well as those ewes that have prolapsed or have shown that they are prone to a prolapse condition. A ewe that does not breed one time will lose a significant amount of her lifetime production potential. It will take the returns of 2–3 productive ewes to pay for the maintenance of one open ewe."

[37] Marshall, et al., "Traditional Livestock Breeding Practices" (2016): 544. The all-female group of Somali pastoralists actually considered infertility in does the most important criteria for culling.

[38] For an Old Babylonian letter listing several undesirable or unacceptable conditions in ewes (including advanced age, [abdominal] bloating, and emaciation), see AbB 14 111.

[39] As pointed out by Ajay Kumar Ishwar, abdominal palpation and ballotment are only effective as methods to detect pregnancy in sheep and goats during late gestation. Ishwar further notes that access to reliable techniques for early detection of pregnancies are important to aid the culling of infertile ewes and does in the herd (Ishwar, "Pregnancy Diagnosis" [1995]).

pregnant ewes and does in the herd, and therefore also the animals that failed to conceive. All sexually-mature female animals are expected to reproduce in any meaningful breeding scenario, and non-pregnant ewes and does should therefore be identified at this point and considered for possible culling. Other ewes and does may have successfully conceived, but would then fail to give birth or take care of their offspring. Such animals would typically be identified wandering about with a bloodstained or wet rear end, but without any sign of a healthy lamb or kid. These ewes or does have either aborted or given birth to healthy lambs/kids which they have then abandoned. These ewes/does can be paired with newborn lambs/kids whose mothers have died during their birth,[40] or be identified and set aside for culling in order to improve the long-term productivity of the herd.

Why would we expect animal infertility and non-conception among ewes and does to be recorded, while pregnancies were not? Because all sexually mature ewes and does were expected to conceive every year, and approximately one-third of the lives of all healthy female sheep and goats would be in a state of pregnancy. This would have been the norm for over 90% of the Ur III ewes and does, and the identification and recording of pregnancies in the textual record would therefore not serve any administrative purpose.[41] On the other hand, the much rarer occurrences of infertility, abortion, or non-conception among the ewes/does would certainly justify inclusion in the administrative record, primarily because any productive animal management system (modern or ancient) would require some form of reaction to these occurrences, but also because of the standard practice within the Ur III administration to record anomalies rather than normative or expected conditions. Infertility or non-conception in ewes and does would be rare, whereas annual pregnancies would be the expectation for all sexually mature ewes and does.[42] Indeed, the numbers of animals classified with $sila_4$/$maš_2$ nu_2/nu-a in the different Ur III texts are typically very modest. Note, e.g., AUCT 2 386 (lines 1–6) from the seventh month of Šu-Suen 9, in which a total of 631 animals are documented as comprised of 213 sheep (udu), 94 ewes (u_8), 30 "messenger lambs" ($sila_4$ kin-gi_4-a)[43] and 294 yearling lambs ($sila_4$ gub), with a specific notation added that the group of animals—including the ninety-four ewes—did not include any u_8 $sila_4$ nu_2-a.

Finally, Steinkeller pointed out that in Puzriš-Dagan, animals classified as ba-$uš_2$ referred to both slaughtered animals and animals dead by natural causes (such as by disease or accident), and that we therefore should not presuppose that these ewes and does were transferred to the slaughterhouse.[44] However, as noted by Wu (see below), this argument is of no consequence for our understanding of the classification of these animals, since the animals described with the expression clearly were intended for human consumption (often by the king himself), and that only slaughtered animals would be consumed by humans in the Ur III period, and never the ones dead by natural causes.[45]

Infertile—Again

Almost immediately after Steinkeller's response and rejection of Heimpel's theory appeared in the *Bulletin on Sumerian Agriculture*, Wu published a comprehensive article on the exclusive royal institution referred to as

[40] See Beck, *Nomad* (1991), 106. For an Old Babylonian reference to the practice of pairing available ewes with abandoned or orphaned lambs, see Richardson, *Texts from the Late Old Babylonian Period* (2010), 53 (TLOB 1 76).

[41] A study of a village breeding program of the Arabic sheep native to the Khuzestan province of Iran has shown an average lambing rate of 95% with 1.08 lambs per birth, and an average of one ram for every twenty ewes in the herd (Haghdoost, et al., "Estimates of Economic Values" [2008]: 92). Note that the Ur III administration's projected reproduction rate in ewes kept for wool in Umma and Lagaš appears to have been only 50%. However, this does not reflect the actual rate, since the projection is based on overall herd growth, and assumes that no animals in these herds would ever die. The rate of death in sheep herds in Old Babylonian Larsa was 15%, and if this percentage is applied to the Ur III herds in Umma and Lagaš, the modest annual growth projected for these herds (25%) would in fact require an 80% reproductive rate in the ewes (see Liverani and Heimpel, "Observations on Livestock Management" [1995]: 142–44).

[42] Cf. the Ur III worker lists, in which any (rare) occurrences of sickness among the workers would always be highlighted, whereas the fitness and overall readiness of the workers would be the expectation, and therefore not specifically recorded in the lists (see e.g. Widell, "Two Ur III Texts from Umma Management" [2009]).

[43] The $sila_4$ kin-gi_4-a referred to male lambs that possibly were destined to be slaughtered for the purpose of divination and extispicy (see Heimpel, "Bezeichnungen von Schafen und Ziegen" [1993]: 131–32).

[44] Steinkeller, "Sheep and Goat Terminology" (1995): 55. For further discussion on the term ba-$uš_2$, see Englund, "Worcester Slaughterhouse Account" (2003); and Tsouparopoulou, "Killing and Skinning" (2013): 153.

[45] According to Adams, animals dead by natural causes would in the Ur III period be given to dogs and servile women, while slaughtered animals were destined for elite consumption and cult observances (Adams, "Shepherds at Umma" [2012]: 152).

e_2-uz-ga, in which he revisited the debate of the meaning of u_8/ud_5 $sila_4$/$maš_2$ nu_2/nu-a. Wu agreed with Landsberger and others that the nu_2, "to lie down," was the actual and intended verb in the expression, and that the nu was only a phonetic rendering of the complicated sign nu_2 introduced from the fourth year in Amar-Suen's reign. However, Wu then concurred with Heimpel's broader understanding of the expression, and argued that the expression was used to describe infertile animals, and he further expanded the meaning to also include ewes and does which, for one reason or the other, had either aborted their fetuses or given birth to stillborn lambs and kids.[46]

Wu offered the very simple and seemingly reasonable translation and analysis of the expression as "ewe/doe (whose) lamb/kid lay down" where the "lying down" should be understood as an idiomatic expression for "dead."[47] According to Wu, the scribal convention of using the sign nu instead of nu_2 from Amar-Suen 4 and onwards, would with this interpretation be even more reasonable, since the expression "ewe/doe who has no lamb/kid" would be synonymous, or at least interchangeable, with an expression meaning "ewe/doe (whose) lamb/kid lay down (in death)."[48]

Like all previous interpretations of the expression, Wu's analysis and his final conclusions in his 1996 article were primarily based on the contexts in which the expression occurred in the Ur III texts. Like Heimpel before him, he strongly rejected the idea that pregnant animals should be earmarked for consumption. As for Steinkeller's observation that the term ba-$uš_2$ in Puzriš-Dagan was used for both slaughtered animals and animals that died of natural causes, he argued that the animals were specifically delivered to the kitchen (e_2-muhaldim) or the exclusive e_2-uz-ga institution, and that Sumerians only ate animals that had been slaughtered and not ones which had died by natural causes. According to Wu, a regular practice of butchering pregnant animals for consumption would be in complete violation of all common sense.[49]

Reproductive Patterns of Domestic Sheep and Goats

Although Heimpel and Wu both have presented some valid arguments in favor of an interpretation of u_8/ud_5 $sila_4$/$maš_2$ nu_2/nu-a as a designation used for infertile ewes and does, or otherwise poor breeders, the traditional understanding of the expression as "pregnant" has prevailed in the scholarly literature.[50] Moreover, as the above review of previous scholarship regarding the meaning of the Sumerian expression demonstrates, the debate so far has primarily been concerned with linguistics and, perhaps more than anything else, arguments based on what we would consider common sense.

What has been almost entirely omitted in the discussions so far are data derived from the fields of zoology and ruminant embryology, which can be of significant help for our understanding of these references. For example, they could tell us what sheep and goat breeders already know, namely that the estrus activity in sheep and goats is naturally seasonal: unlike most other domestic livestock species, sheep and goats maintained at temperate latitudes (> 25°) typically have a marked seasonality of breeding activity.[51] This phenomenon, which is a manifestation of a reproductive strategy for the survival of the species, is a result of the fact that ewes and does ovulate naturally in response to the shortening of the day and the decrease in daylight hours that occurs in the fall.[52] Sheep and goats are so-called "short day" breeders, which means that during the short photoperiods in the autumn, the production and release of melatonin from the pineal gland will stimulate sexual activity

[46] Wu, "Ewes Without Lambs" (1996): 65–66.

[47] Wu did not consider that ewes and does, like many other domesticated animals, often (but not always) give birth lying down. However, he pointed out that there is a clear connection between the Akkadian verb *niālum*, "to lie down," and death in early Mesopotamia (*ibid.*: 67). As for the (rare) use of "to lie down" as a euphemism for "sexual intercourse," it is important to point out that this only applies to sexual intercourse that involves humans and/or anthropomorphic deities, and no evidence suggests (and we have no reason to assume) that animal reproduction was considered a horizontal activity in ancient Sumer.

[48] Wu, "Ewes Without Lambs" (1996): 66–67. Note, however, that the syntactic structure of the two expressions remains different with this interpretation, since the $sila_4$/$maš_2$ would be the subject of nu_2-a, but the direct object of nu-a.

[49] *Ibid.*: 72.

[50] E.g., Sara Brumfield's recent edition of the text AA76, where she translates u_8 $sila_4$ nu-a, "pregnant ewes," with a reference to Steinkeller's article from 1995 (Brumfield, "The Term ab_2-RI-e" [2011]). Note also Wu, who despite his own discussion and rejection of the expression as a reference to pregnant animals in 1996, simply offered the translation "ewe/nanny goat with (or without) lamb/kid," without any further comments, in his paper on the cooks working in the e_2-uz-ga institution in Puzriš-Dagan (Wu, "Pairs of Cooks" [2013]).

[51] Simões, "Synchronization of Ovulation" (2015).

[52] See, e.g., Chemineau, et al., "Control of Sheep and Goat Reproduction" (1992); Rosa and Bryant, "Seasonality of Reproduction" (2003).

in the females. Conversely, seasonal anoestrus occurs when the day length increases in the spring, and this period is associated with an *absence* of estrus and ovulation in sheep and goats. In other words, there is a season during which the sheep and goats are pregnant, and there is a season during which they are not, although the seasonality can be somewhat manipulated and changed, and this was possible also in antiquity according to management practices and environmental conditions.

Since the majority of the Ur III references to the expressions u_8 $sila_4$ nu_2/nu-a and ud_5 $maš_2$ nu_2/nu-a are dated by month according to the Puzriš-Dagan calendar, the seasonality of the breeding activity of the animals in the livestock center is imperative to our understanding of the expressions (on which, see below). Important data on reproduction cycles and birth seasonality of ancient sheep and goats can also be obtained through the analysis of tooth enamel oxygen isotope ratios.[53] Recently, a team of scientists examined ten third molars belonging to ten different sheep from the Later Pre-Pottery Neolithic – B (ca. 7500 cal BC) from the Mesopotamian site Tell Halula in the Middle Euphrates Valley, Syria.[54] The analysis indicated that the ten sheep, which were all slaughtered around two to six years, were all born within a short time period of ca. 2.5 months (0.22 year), offering clear evidence of a marked seasonality of birth and fertility in early Mesopotamian herds.

While herding practices in Neolithic Tell Halula no doubt would have differed from the more intensive sheep/goat management strategies of the Ur III period, the data is important since it provides evidence for regional birth seasonality in herds that likely were primarily kept for meat production.[55] Although there is some evidence of secondary animal products in the Middle East in the Neolithic,[56] there is no conclusive evidence in the faunal remains that this was more than opportunistic in this early period. Moreover, the analysis of the bone fragments from the site has demonstrated that most sheep in Tell Halula were culled as juveniles and subadults (52.3% of sheep specimens were killed within their first year), with a sex-ratio distribution in favor of females (increasing over time). This would be typical for herd structures focused on meat production as well as intensification of breeding and herd reproduction.[57]

Sheep and goat populations in current Iran provide us with a rough biological life cycle of ruminants that is unlikely to have been much different in antiquity. According to R. M. Acharya, who provided an overview of small ruminant production in arid and semi-arid regions in Asia in the 1980s, about 60% to 70% of the flocks in Iran are transhumant, migrating long distances following the seasonal growth, while the remaining 30% to 40% are stationary flocks where the animals are kept on grazing lands surrounding villages.[58] Mating in both the transhumant and stationary flocks would usually take place in September to October, over a period varying from thirty-five to forty days, although some data indicated that a minority of herders would keep their rams with the ewes for longer periods of time to try to increase productivity. The lambing season would typically occur in February and March and be followed by a period of roughly four months when the animals were anoestrus, and not able to breed.[59] To a goat or sheep breeder, this state is referred to as post-partum anoestrus, or PPA.

Ethnographic studies of pastoral tribes in Iran have produced very similar data, with lambs and kids being born during a short period of time in the late winter/early spring among the Qashqa'i,[60] or from early February to the middle/end of March among the Baxtyâri.[61] The breeding cycle for both transhumant and stationary flocks of sheep and goats in Iran may be summarized thusly:

Mating: September–October (thirty-five to forty days)
Birth: February–March
Anoestrus: April–July

[53] E.g., Balasse, et al., "Determining Sheep Birth Seasonality" (2003); Balasse, et al., "Investigating Seasonality and Season of Birth" (2012); Blaise and Balasse, "Seasonality and Season of Birth" (2011); Tornero, et al., "Seasonality and Season of Birth" (2013).

[54] Tornero, et al., "Seasonal Reproductive Patterns" (2016).

[55] See Sherratt, "Plough and Pastoralism" (1981) and "Secondary Exploitation of Animals" (1983).

[56] See Greenfield, "Secondary Products Revolution" (2010).

[57] Tornero, et al., "Seasonal Reproductive Patterns" (2016): 811.

[58] Acharya, "Small Ruminant Production" (1986). In her recent monograph on early Mesopotamian pastoralism, Anne Porter has argued for a less pronounced socio-political distinction between nomadic, semi-nomadic, and sedentary communities in the ancient Near East, and suggested that transhumant pastoralists in early Mesopotamia in fact belonged to the same social, political, and familial entities as farmers, although concrete evidence for this radical reinterpretation remains somewhat tenuous (Porter, *Mobile Pastoralism* [2012], 13–14; see also the reviews by Mitchell Rothman (2014) and Steve Rosen (2015).

[59] Simões, "Synchronization of Ovulation" (2015): 158.

[60] Beck, *Nomad* (1991).

[61] Digard, *Techniques des nomades* (1981).

Archaeological and ethnographic data suggest that mating and birth was seasonal among sheep and goats in Mesopotamia, and we would expect this seasonality to be reflected in the monthly distribution of references to ewes and does classified as $sila_4$/$maš_2$ nu_2/nu/a in the Ur III documentation from Puzriš-Dagan.[62]

Discussion and Analysis of the Textual Data

Of the ca. 16,000 published cuneiform tablets from Puzriš-Dagan, approximately 1,200 were never dated by month, or do not have preserved or legible month formulas. According to the BDTNS website, eighty-one of the remaining tablets with month formulae offer ninety-nine references to ewes classified as $sila_4$ nu_2/nu-a, while ninety-four tablets provide 131 references to does classified as $maš_2$ nu_2/nu-a. These references are typically used for single ewes or does, or for smaller groups of animals, although there are a few exceptions where more significant numbers of animals are recorded in single texts (e.g., TRU 405, AUCT 3 67, Princeton 2 72, SAT 3 1927). Taking appropriate measures to avoid any double-counting (some references are clearly repeat listings of the same animals), we may conclude that these tablets together list a total of 268 ewes and 345 does classified as $sila_4$/$maš_2$ nu_2/nu-a.

To provide a direct conversion of the Ur III months to the months in our modern calendar is complicated, because the twelve-month lunisolar calendar used in ancient Mesopotamia was approximately eleven days shorter than the seasonal (solar) year, which of course has been used to (artificially) set the length of our months. In order to synchronize the lunisolar calendar with the seasonal year, the Ur III administrators would insert an intercalary thirteenth month every two to three years. In other words, depending on the local intercalary cycle, the first month in the Ur III calendar used at Puzriš-Dagan could correspond to April in one year, but to May in another year, and the month conversions used here can therefore only be taken as rough estimates.[63]

Nevertheless, these approximate conversions allow us to compare the seasonal distribution of Ur III references to ewes and does classified as $sila_4$/$maš_2$ nu_2/nu-a with the seasonal reproductive cycles of Mesopotamian sheep and goats.[64] There is a clear (and expected) correlation between the seasonal distribution of tablets recording $sila_4$/$maš_2$ nu_2/nu-a (see Figure 1), and the distribution of the number of actual animals with the classification (see Figure 2). With the exception of July/August (the fourth month in Puzriš-Dagan), ewes and does classified with $sila_4$/$maš_2$ nu_2/nu-a were observed and recorded throughout the year, with two clearly distinguishable peaks during the periods of mating and birth, and a pronounced and expected decline of attestations during the summer months when the females were anoestrus. The data supports the marked seasonality of birth and fertility in sheep and goats of the Ur III period, as suggested by ethnographic studies and the analysis of oxygen isotope ratios of tooth enamel in ancient Mesopotamian sheep.

The clear increase in attestations of $sila_4$/$maš_2$ nu_2/nu-a immediately before (January/February) and during the birth season (February/March), could perhaps reflect an increase in observations and recordings of pregnancies, and would thus support the original interpretation of the expression as a classification for pregnant animals. However, the large number of attestations in April/May appear too late in the year for sheep and goat pregnancies in Mesopotamia, and it is unlikely that these attestations refer to pregnant animals. A more plausible interpretation would therefore be that the earlier attestations in this accumulation (December/January) represent non-pregnant animals, whose failure to conceive during the mating period is becoming apparent to the shepherds. The observations and records from the actual birth season (February/March) would primarily represent animals which had aborted their fetuses, abandoned their offspring, or given birth to stillborn lambs/kids. Finally, the later attestations from April/May (and onwards during the anoestrus period) would simply be observations and records of ewes and does without lambs/kids.

[62] The pregnancy and gestation of domesticated sheep and goats are more or less identical, and their reproductive patterns can therefore be treated together. Both sheep and goats have their natural breeding seasons in the fall, with gestation periods averaging around 150 days, although the precise length varies slightly from breed to breed.

[63] For the nature of the Sumerian calendar and the use of regular and intercalary months in the Ur III administration, see Sharlach, "Calendars and Counting" (2013), 313–15.

[64] Note that the three texts AUCT 3 67, Princeton 2 72, and SAT 3 1927 from the first month of Ibbi-Suen 1 have been excluded in the comparisons. These texts list large numbers (27, 20, and 20) of u_8 $sila_4$ nu-a as a part of Sippar's transfer of sheep to Puzriš-Dagan within the city's bala obligation to the Ur III state (see Sharlach, *Provincial Taxation* [2004], 368), and these animals clearly did not form a part of the regular livestock management activities at Puzriš-Dagan.

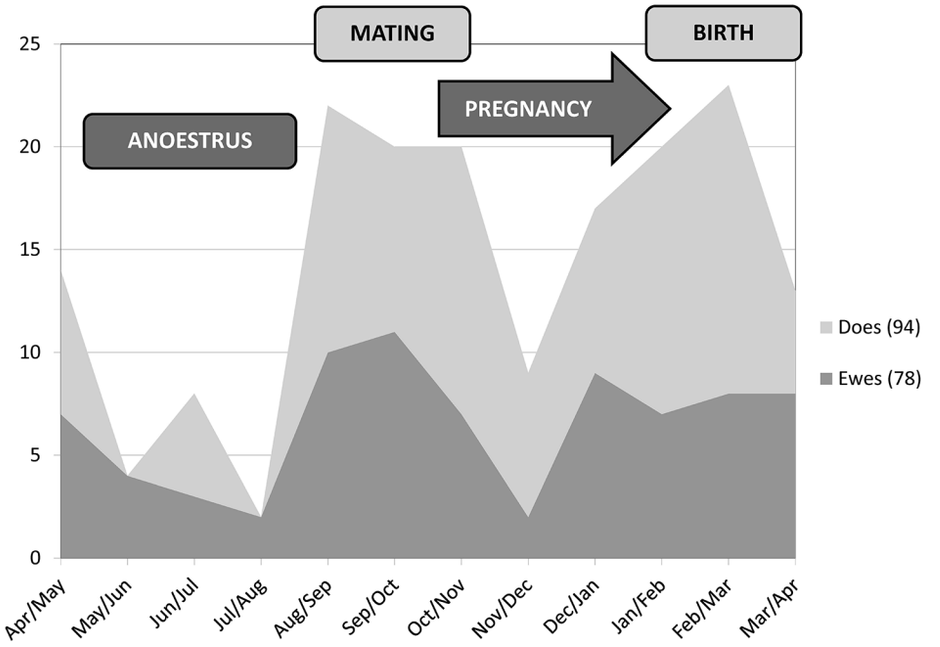

Figure 1—Seasonal distribution of Ur III tablets listing ewes and does classified as $sila_4$/$maš_2$ nu_2/nu-a compared to a reconstruction of the breeding cycle of Mesopotamian ewes and does.

The other pronounced increase in references to ewes/does classified as $sila_4$/$maš_2$ nu_2/nu-a coincides with the mating period (September/October). As mentioned above, pregnancies in sheep and goats can only be determined during the later stages of gestation by means of a visual inspection or abdominal palpation (the two methods available to the ancient shepherds), and these records made in September/October/November can therefore not be references to pregnant animals. Instead, it seems likely that they refer to animals which for some reason were not coming into heat, and therefore were not mounted by the rams/bucks. As

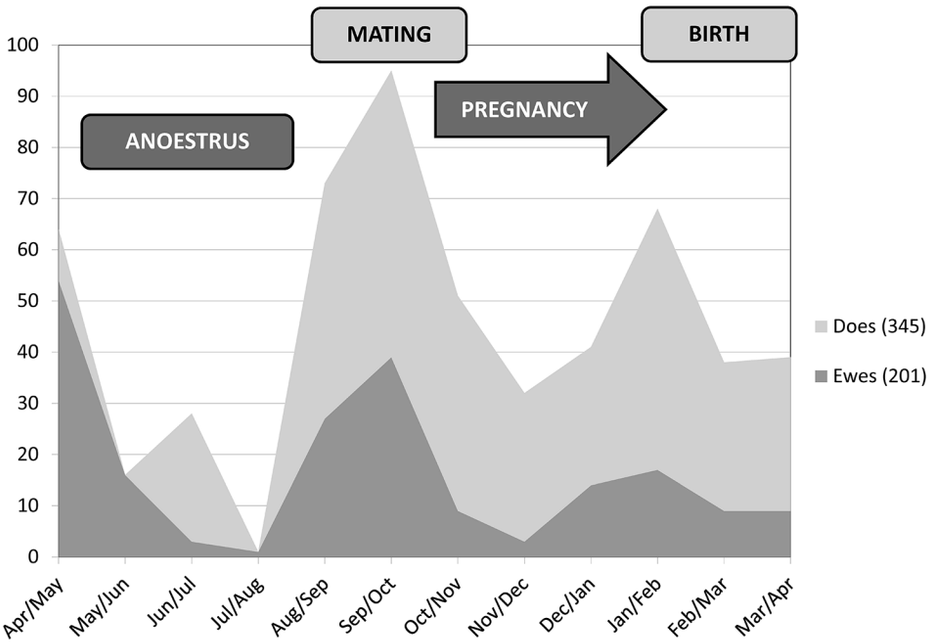

Figure 2—Seasonal distribution of the numbers of ewes and does classified with $sila_4$/$maš_2$ nu_2/nu-a in the Ur III tablets compared to a reconstruction of the breeding cycle of Mesopotamian ewes and does.

mentioned above, sexually mature ewes and does that have failed to breed for two or three estrus cycles should be identified and considered for culling. Once the mating period is over, there was a sharp decline in the attestation of ewes and does classified as $sila_4$/$maš_2$ nu_2/nu-a, which lasted until the later stages of gestation when pregnancies (and therefore also animals not being pregnant) become possible to determine based on observation alone.

The Ur III State and Puzriš-Dagan

The consumption of animals and the slaughtering patterns within the organization of Puzriš-Dagan remained largely unaffected by the seasonality and season of births among the sheep and goats in the various herds of the livestock center. For example, no clear pattern can be identified in the seasonal distribution of the 676 texts returned by BDTNS, recording šu-gid_2 deliveries of animals to the kitchen in Puzriš-Dagan (šu-gid_2 e_2-muhaldim).[65] The mean number of tablets for each month was fifty-three (median: fifty-three), with a sample standard deviation (s_x) of eight. More significantly, the royal bureaucracy of Puzriš-Dagan would not appear to have allowed the inherent mating and birth seasonality in the small livestock herds to disrupt the timing of the frequent animal deliveries from the pastoral communities within the Ur III state and its outlying territories.[66] Such deliveries to Puzriš-Dagan were meticulously recorded in the so-called mu-ku_x (DU) delivery tablets.[67] According to the BDTNS, a total of 3,080 texts record mu-ku_x (DU) deliveries of livestock to the center, of which 2,894 can be dated to one of the twelve regular Sumerian months used in Puzriš-Dagan. The texts are distributed remarkably consistently over the twelve months of the year, displaying only a slight increase in numbers during the autumn, with close to half of the texts (approximately 47%) dated to the Sumerian months 5–9. The monthly mean of tablets was 241 (median: 235), with a sample standard deviation (s_x) of only thirty-five.

As mentioned above, Puzriš-Dagan was specifically founded by king Šulgi to serve the administrative and economic needs of the Ur III state, perhaps as a result of the state's ambition to extend its control over the transhumant pastoralists living in the marginal areas of the state. In this capacity, the city was operating as an administrative instrument of the central authority, without any traditional administrative structures of its own; it was a reflection of the increased administrative and economic domination of the Ur III state.[68] The nature of the interconnection between the livestock management officials operating in Puzriš-Dagan on behalf of the royal administration, and the pastoral communities in the outlying territories fulfilling their various responsibilities to the state, highlights a common problem with centralization of authority and power, in which a central bureaucracy enforced arbitrary and inefficient policies on front-line agencies, thereby disconnecting the state from local and regional communities.[69] As argued by Piotr Michalowski, some of the main causes of the decline and collapse of the Ur III state, after only a century of domination, were in all likelihood embedded in the rigid bureaucratic structures of the central authority, and its relationship and interactions with the local and regional communities of the state.[70]

Conclusions

The analysis of the textual data presented in this article demonstrates a marked seasonality in birth and fertility in sheep and goats managed in the royal livestock center Puzriš-Dagan in the Ur III period, reinforcing the hypothesis that the majority of these animals would have

[65] See Tsouparopoulou, "Killing and Skinning Animals" (2013): 153–54. According to Wu, the animals classified as šu-gid_2, which typically were sent to the kitchen (e_2-muhaldim) rather than the exclusive e_2-uz-ga institution, were of very low quality, and primarily intended for consumption by common servants and soldiers (Wu, "Ewes Without Lambs" [1996]: 72).

[66] Note that a significant number of the animals recorded in Puzriš-Dagan arrived in the form of gifts from notables within the state (high level officials, military commanders, Amorite allies, etc.), often in connection to military campaigns (see Garfinkle, "Limits of State Power" [2013]: 161–62). While some of these animals no doubt also originated from the pastoral communities in the outlying territories, others would have been sourced from within the traditional boundaries of the state from management systems that did not involve our traditional notions of pastoralists.

[67] See, e.g., Maeda, "Bringing (mu-túm) Livestock" (1989).

[68] Tsouparopoulou, *Ur III Seals* (2015), 9; see also Garfinkle, "Was the Ur III State Bureaucratic?" (2008), 58; Porter, *Mobile Pastoralism* (2012), 306–307 and 324.

[69] A similar observation was made by Melinda Zeder in her 1994 study of administrative procedure and animal management in Puzriš-Dagan, where she concluded that the administrative and bureaucratic routines and needs of the Ur III state were prioritized over issues related to animal husbandry and herding practices: Zeder, "Specialized Animal Economy" (1994), 186.

[70] Michalowski, "Charisma and Control" (1991): 53 and 56–57.

been brought in from pastoral systems north of Babylonia (around or above the 35th parallel). The data show a short mating season in the autumn (September–October), with lambing taking place in the early spring (February–March). This breeding pattern resembles the reproductive sheep and goat cycles found in traditional husbandry systems of both transhumant and sedentary herds in modern-day Iran, and appears to be further supported by a recent study of oxygen isotope ratios of tooth enamel from ancient sheep from Tell Halula in the Middle Euphrates Valley in modern Syria.

The breeding cycle of the sheep and goats help us in establishing the import of the Sumerian expression u_8/ud_5 nu_2/nu-a as a classification used for ewes and does in Puzriš-Dagan which for various reasons were unable to conceive or give birth to healthy lambs/kids, possibly to be literally translated as "ewe/doe (whose) lamb/kid lay down (in death)." The prompt identification and removal of infertile or non-productive animals is essential in any productive animal management system, and the evidence suggests that the Ur III ewes/does without lambs/kids were destined for culling and subsequent human consumption. They were frequently dispatched to the state-controlled kitchen or commissariat, or to the enigmatic establishment referred to as e_2-uz-ga, which prepared food for the king and the royal court.

The seasonality of the reproductive cycle would have had an impact on the availability of secondary animal products from sedentary and transhumant herds in the marginal areas of the Ur III state. Seasonality would also have constituted a major factor for the management strategies and overall movements of the transhumant herders and pastoralists, who ultimately provided a significant portion of the animals. However, the cuneiform texts recovered from Puzriš-Dagan do not indicate that the central authority of the Ur III state accommodated in its bureaucratic routines this marked seasonality of breeding activity in the sheep and goats brought in from these communities. Livestock continued to be collected and recorded in the archives of Puzriš-Dagan throughout the year, with no discernible interruptions or seasonal fluctuations, highlighting the detachment and disconnect between the bureaucratic system established by the Ur III kings and the regional communities upon which the state ultimately relied.

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